Comments on the Body Mass Trend of *Ondatra zibethicus* (Rodentia: Muridae) During the Latest Pleistocene

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ABSTRACT—Martin (1993) suggested, in his investigation of the phyletic evolution in the rodent genus *Ondatra*, that an increase in body mass through time has occurred in *Ondatra zibethicus*, with the increase in size being concentrated in the last 600,000 years before present (y.b.p.). *Ondatra zibethicus* apparently obtained its greatest body mass during the latest Pleistocene, followed by a sharp decrease in body mass into Recent times, referred to as a "dwarfing event." We examined fossil muskrats from late Pleistocene sites in South Carolina, Florida, and additional Recent material which do not support the proposed "dwarfing event" of *O. zibethicus* at the close of the Pleistocene. As more fossil material becomes available, future research could provide a clearer picture of the body mass trend in *Ondatra zibethicus*.

METHODS

Two recently discovered late Pleistocene sites, Crowfield local fauna and the Ardis local fauna (Bentley et al. 1994) yielded fossils of *Ondatra zibethicus*. These remains, coupled with unpublished material from the Aucilla River, Florida, and Recent specimens from Iowa and Georgia provided new data elucidating body mass trend for this taxon during the latest Pleistocene. It is not within the scope of this paper to do a thorough review of the literature on muskrat body mass nor extensive studies of museum collections. A project of this magnitude would encompass an undertaking much larger than this note. The data published here are intended to elicit further research into the trends of muskrat body mass at the close of the Pleistocene.

Boyce (1978) noted a small degree of sexual dimorphism in muskrats with males slightly larger than females. However, because this difference is slight, and sex cannot be determined from fragmentary fossil material, the effects of sexual dimorphism can not be assessed in this study.

All measurements were done on the first lower molar (m1). Measurements were taken three times with calipers and rounded to the nearest 0.01 mm.

Table 1. Length of m1 and projected body mass for Recent and Pleistocene muskrats.

Iowa (Recent)			Georgia (Recent)			Ardis L.F., S.C.			Crowfield, S.C.			Aucilla River, FL		
Museum Number	m1 (mm)	Mass (kg)	Museum Number	m1 (mm)	Mass (kg)	Museum Number	m1 (mm)	Mass (kg)	Museum Number	m1 (mm)	Mass (kg)	Museum Number	m1 (mm)	Mass (kg)
SCSM	7.42	0.95	pr.col.	8.0	1.24	FLMNH	8.0	1.29	SCSM	6.8	0.69	132680	8.8	1.75
SCSM	7.4	0.95	pr.col.	8.1	1.30	FLMNH	8.1	1.3	SCSM	6.9	0.73	132679	7.7	1.1
SCSM	8.14	1.32			$\bar{x}$ 1.27	FLMNH	6.7	0.66	SCSM	7.3	0.89	132681	8.8	1.75
SCSM	8.12	1.31				FLMNH	7.9	1.19	SCSM	7.5	0.98	133219	7.2	0.85
SCSM	7.45	0.96				FLMNH	7.85	1.16	SCSM	7.8	1.3	132674	7.0	0.77
SCSM	7.23	0.86				(.32)	7.25	0.87			$\bar{x}$ 0.92	132675	7.1	0.81
SCSM	6.95	0.75				(.36)	7.05	0.79			SD 0.22	132676	7.5	0.98
SCSM	7.0	0.77				(.33)	7.8	1.13				132678	7.2	0.85
SCSM	7.03	0.78				(.34)	7.2	0.85				132677	6.3	0.53
SCSM	7.04	0.78				(.37)	7.31	0.89				133220	7.7	1.18
SCSM	8.34	1.44				(.38)	6.85	0.71				133218	7.9	1.19
SCSM	7.73	1.1				USNM	7.85	1.16				131317	7.8	1.1
SCSM	6.92	0.74				USNM	7.25	0.87				131315	6.9	0.73
SCSM	7.41	0.94				(.39)	7.1	0.81				131319	7.0	0.77
SCSM	7.7	1.08				USNM	7.15	0.83				131318	8.0	1.2
SCSM	6.95	0.75				USNM	6.85	0.71						$\bar{x}$ 1.04
SCSM	7.55	1.01				USNM	7.0	0.77						SD 0.34
SCSM	7.27	0.88				pr.col.	7.85	1.16						
SCSM	7.67	1.07						$\bar{x}$ 0.95						
SCSM	7.3	0.89						SD 0.21						
SCSM	7.0	0.77												
SCSM	6.84	0.71												
		$\bar{x}$ 0.94												
		SD 0.20												

Fossil specimens from the Ardis local fauna, deposited in the collections of the South Carolina State Museum (SCSM), are designated by the base number S. C. 93.105. and cited in this paper by the two digits following the base number. Specimens from the Crowfield local fauna and Recent unaccessioned specimens at the South Carolina State Museum are denoted by SCSM. Fossil material from the Florida Museum of Natural History is indicated by the accession numbers of 132680 - 131318.

We used a weighted, Wilcoxon rank analysis test to search for statistical significance between our data and Martin's. The data were analyzed over three time intervals: 1) 20,000 y.b.p. to Recent; 2) 20,000 y.b.p. to 10,000 y.b.p.; 3) 20,000 y.b.p. to 15,000 y.b.p. The Wilcoxon rank analysis test was used to compare sample means, as Martin's raw data were not available to us.

INTRODUCTION

Martin (1993) derived a regression formula based on the length of the ml to estimate the body mass of arvicolines: $M = 0.71\ (L)^{3.59}$, where M is body mass in kg and L is the length of ml in mm. He used the formula to help determine the trend in body mass for the polytypic genus *Ondatra* during the last 3.75 million years. Martin noted that most of the change in body mass occurred during the last 600,000 years. Muskrats reached their greatest size (1.75 kg) during the latest Wisconsin between 20,000 and 10,000 y.b.p. This larger form was *Ondatra zibethicus floridanus* (Lawrence 1942), synonymized with *O. zibethicus* by Martin (1993). Martin conjectured that approximately 10,000 years ago it appears that body mass dramatically decreased to the levels he recorded for Recent samples. Martin referred to this decline in body mass as a "dwarfing event." He was unclear as to the cause but mentioned human culling and/or natural selection as possible explanations. Applying Martin's regression formula to fossils from several recently collected late Pleistocene sites in South Carolina and Florida, as well as recent specimens from Iowa and Georgia (Table 1), gives more resolution to this short, but apparently dynamic time interval.

RESULTS AND DISCUSSION

The Ardis local fauna (19,000 y.b.p.) (Bentley et al. 1994) yielded 18 *Ondatra* ml's for which measurements could be taken (Table 1), producing a mean body mass of 0.95 kg. An unpublished fauna from South Carolina, the Crowfield local fauna (80,000 y.b.p.),

under study by Fred Grady of the National Museum of Natural History, produced a sample of six muskrat ml's giving a mean of 0.92 kg. In Florida, an unpublished, late Pleistocene site (12,000–10,000 y.b.p.), from the Aucilla River (Priscilla site, Little River section), under study by S. David Webb (Florida Museum of Natural History, personal communication), yielded 15 ml's with a mean of 1.04 kg. The age of this site is based on numerous radiocarbon dates (Dunbar et al. 1989; S. D. Webb, personal communication).

The senior author obtained 22 muskrat carcasses from a fur buyer in Roselle, Carroll County, Iowa, in December 1992. The sample represents muskrats from populations within a 100-mile radius of Roselle and were probably collected from many different sites. Using Martin's regression formula, these samples produced a mean of 0.94 kg. Measurements of two modern ml's from Georgia (no other data) had estimated mean mass of 1.27 kg.

Comparing these data (Fig. 1) with those of Martin (unpublished data) would suggest that the increase in body mass for the time span covered by our samples was much more subtle than Martin's data would indicate. After Martin's initial body mass increase at 600,000 y.b.p., the upward change in size until Recent is almost negligible. In addition, the statistical analysis of the three time intervals yielded no significant difference between our data and Martin's. Thus, our data do not support Martin's "dwarfing event" at the close of the Pleistocene.

We view the data on which the dwarfing hypothesis was based as having several problems, the most significant of which is sample size. The four samples between 10,000 and 20,000 y.b.p. which constitute the much larger forms of *O. zibethicus* (compared to Recent specimens) are made up of a total of seven ml's, from four sites (Table 2), an extremely small sample size. Furthermore, all of Martin's 10,000–20,000 y.b.p. specimens were recovered from cave faunas (Table 2), a habitat in which modern muskrat populations do not naturally occur. This would suggest that various selection pressures, probably predatory, must be taking place in order for these remains to occur in cave deposits. Thus, the samples from these caves may not be a true representation of nearby local populations.

Assuming that Martin's regression for body mass holds true, it seems highly probable that a "dwarfing event" has not occurred between the latest Pleistocene and contemporary times based on this new material. However, this has little consequence for the overall trend in muskrat body mass over the past 3.75 million years. When this time period is re-scaled to a common interval length, Martin (1993) states that the dwarfing event ". . . appears to be only moderately pronounced."

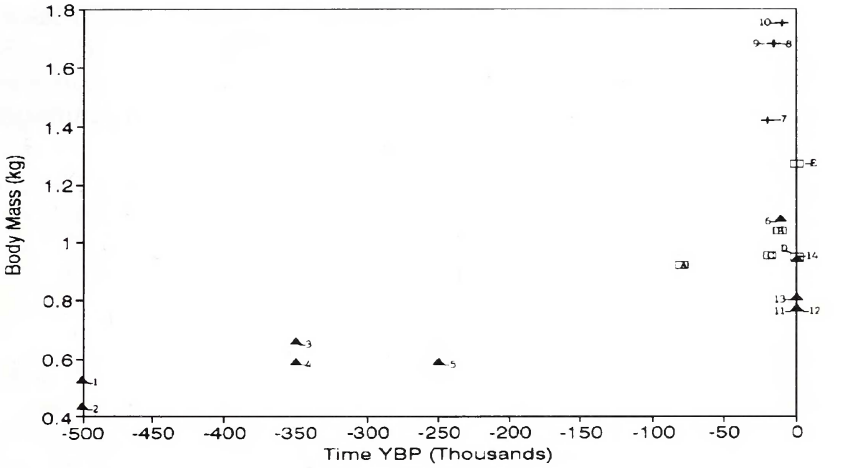

Fig. 1. Mean body mass trend of *Ondatra zibethicus*. Solid triangles: sample means for non-cave faunas reported by Martin (1993). Plus symbols: sample means for cave faunas reported by Martin (1993). Open squares: sample means for non-cave faunas (from Table 1). Overlapping samples are denoted by two location numbers. Numbers and letters indicate location of the samples (from Table 2).

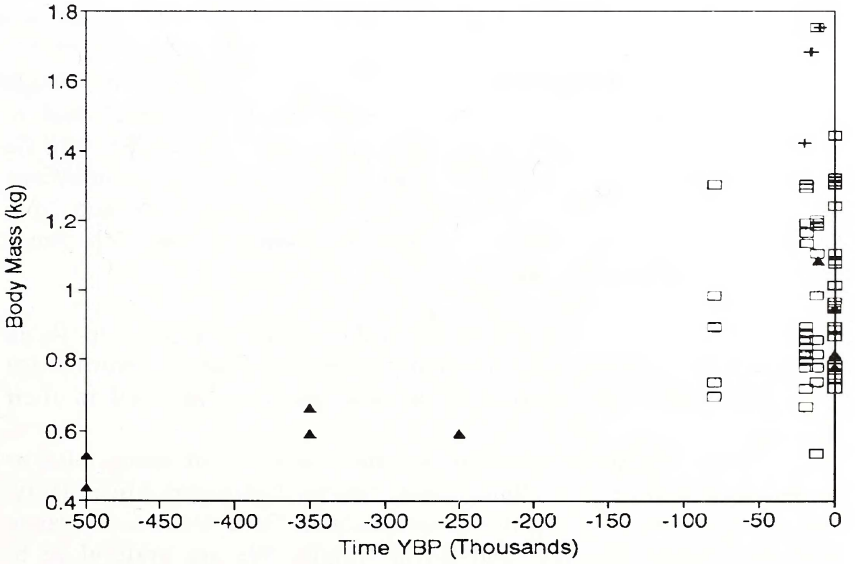

Fig. 2. Comparison of raw versus mean data points for *Ondatra zibethicus*. Solid triangles and plus symbols are Martins' (1993) sample means. Open squares are Bentley and Knight's raw data (from Table 1).

Table 2. Location, sample size, and age of muskrat specimens.

Locality	Sample Size	Age (y.b.p.)	Source
1-Mulen 3	6	500,000	Martin (unpublished)
2-Kanopolis	1	500,000	" "
3-Hay Springs	7	350,000	" "
4-Anderson/Flohr	2	350,000	" "
5-Doby Springs	11	250,000	" "
6-Ichetucknee River	23	11,000	" "
7-Bell Cave Z3	3	20,000	" "
8-Bell Cave 1/2	1	15,000	" "
9-Yarbrough Cave	2	16,000	" "
10-Kingston Cave	1	10,000	" "
11-Louisiana	31	Recent	" "
12-Br. Columbia	10	Recent	" "
13-Nebraska	10	Recent	" "
14-New Jersey	17	Recent	" "
A-Crawfield	5	80,000	Bentley & Knight (Table 1)
B-Aucilla River	15	12-10,000	" "
C-Ardis L.F.	18	19,000	" "
D-Iowa	22	Recent	" "
E-Georgia	2	Recent	" "

We believe the "dwarfing event" is an artifact of small sample sizes and selection bias and not a dramatic evolutionary response to some environmental change. However, further data are needed to provide a more definitive answer to the true body mass trend of *Ondatra zibethicus* during the latest Pleistocene. As fossil collections are amassed from the latest Pleistocene a clearer picture may develop, resolving trends that cannot be discerned here.

ACKNOWLEDGMENTS—First and foremost we wish to thank personnel of the Giant Cement Plant, Harleyville, South Carolina, for their generous cooperation and patience while we worked in their quarry.

We also wish to recognize all those who toiled along with us in the field: Vance McCollum, Linda Eberle, Craig and Alice Healy, Derwin Hudson, Ray Ogilvie, Lee Hudson, Tom Reeves, Suzanne Boehme, Martha Bentley, and Karin Knight. We are grateful to S. David Webb and Gary Morgan, Florida Museum of Natural History, Gainesville, Florida, for allowing us access to the University of Florida collection and for critical reviews of this manuscript. Particular thanks

go to Robert A. Martin who kindly provided us with his unpublished manuscript, and whose critical review of this work greatly improved its relevance. We also wish to express our appreciation to Mike Trinkley and Debi Hacker of the Chicora Foundation, Columbia, South Carolina, and to David Wethey, Sara Woodin, and Wallace Dawson for their input on this manuscript. Finally, thanks go to Overton Ganong, Director of the South Carolina State Museum, for other courtesies.

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Received 8 March 1994
Accepted 30 August 1994